

DETAILED STUDY OF NON-MERCURY ALTERNATIVES AS AN ENVIRONMENTAL ATTRIBUTE



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1.0 INTRODUCTION

The Defense Logistics Agency (DLA) has collaborated with the military services and other Federal agencies, including the U.S. Environmental Protection Agency (US EPA), the U.S. Department of Agriculture (USDA), and the General Services Administration (GSA), to add a new element to the Federal Logistics Catalog System. This new element, called an Environmental Attribute or Characteristic code (ENAC), identifies products that are environmentally preferable over other similar products, and signifies that the product meets strict, definable environmental standards and criteria from an approved environmental body. Military and Federal agency customers worldwide can buy environmentally preferable products (EPPs) from DLA with confidence in knowing that the ENAC criteria have been reviewed and approved by a consensus of the military services and Federal agencies through the DLA-chaired Joint Group on Environmental Attributes (JGEnvAtt).

DLA is currently evaluating additional factors for consideration as new environmental attributes in the Federal Logistics Information System (FLIS). This paper provides a detailed study of **non-mercury alternatives** for consideration as an environmental attribute.

2.0 APPROACH

The JGEnvAtt Coordinating Committee developed three criteria for evaluating potential environmental attributes:

- They must be a *policy priority*;
- They must be readily definable; and
- They must show life-cycle cost savings.

Policy Priority refers to attributes that are established by laws, regulations, Executive Orders and other directives. Policy Priority also refers to attributes that are addressed by policies or management goals of the military services.

Readily Definable means that specific definitions and criteria must be available from governing bodies and / or recognized standards setting organizations. The environmental attribute must contain information that is not only readily understandable, but in addition, will specify that a product is preferable over a similar product that performs the same function. As such, the environmental attribute must relate a clearly defined and quantifiable characteristic.

Life-Cycle Savings means that usage of the product will result in cost savings to the government over the lifetime of the product. Executive Order 13101 and other Federal directives require that government agencies and the military services consider life-cycle costs in acquisition planning.

Some of the most significant benefits of using Environmentally Preferable Products are typically found in reduced costs associated with:

- Materials storage and handling
- Use of energy, water and other resources
- Waste stream management, treatment and disposal
- Compliance, permitting and reporting
- Liability from work-related injuries and environmental contamination

This report details the results of research, meetings, and discussions held to compile information on mercury and the non-mercury alternatives relative to the three evaluation criteria. This information was used to develop non-mercury alternatives product categories and to recommend how to implement the environmental attribute.

3.0 POLICY PRIORITY

Research indicates that mercury **is** a policy priority due to the existence of national and state policies restricting its use. Applicable policies are described below.

3.1 EXECUTIVE ORDER 13101

Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition,"¹ requires Federal agencies to consider the environmental impacts of their procurement decisions. The order requires DLA to operate an affirmative procurement program in accordance with Section 6002 of the Resource Conservation and Recovery Act (RCRA). Use of non-mercury products helps achieve several of the objectives of the order, most notably toxicity reduction.

3.2 EXECUTIVE ORDER 13148

Executive Order 13148 applies to all federal facilities that interact with the environment, including federal laboratories, maintenance facilities and buildings across all federal departments and agencies. The order requires federal facilities to implement an Environmental Management System (EMS) standard known as ISO 14001; 1996. The order sets goals for reducing toxic chemical emissions (including mercury) by 40% by December 31, 2006 from 2001 baseline levels.

Section 503 of EO 13148, requires that a Federal Interagency Workgroup develop a priority list of chemicals used by the Federal Government that may result in significant harm to human health or the environment and that have known, readily available, less harmful substitutes for identified applications and purposes². The order further requires that each Federal agency (with certain exceptions) reduce their use of those chemicals for the identified applications by 50% by December 31, 2006. Fifteen target chemicals were identified by the Interagency Workgroup, including mercury in two specific product categories, on the Section 503 Chemical List³: temperature and pressure measuring devices (for medical and industrial uses), and mercury switches. Suggested alternatives include aneroid manometers, digital and electronic temperature

measuring devices, electronic thermostats, mechanical switches, and ultrasonic and photoelectric sensors.

3.3 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Mercury-contaminated hazardous wastes are regulated under RCRA. Existing regulations include the Hazardous Waste Identification Regulations (40 CFR Part 261), the Universal Waste Regulations (40 CFR Part 273), and the Land Disposal Restrictions (LDR) Regulations (40 CFR Part 268). Mercury wastes that are identified as hazardous wastes are subject to applicable management standards, which are contained in 40 CFR Parts 262 through 265, 268, 270, 271, and 124.⁴ Hazardous waste lamps (including many lamps containing mercury) and thermostats⁵ are included in the list of universal wastes regulated under RCRA⁶. In addition, EPA has proposed to regulate mercury-containing equipment under the universal waste rule, including switches, barometers, meters, temperature gauges, pressures gauges, and sprinkler system contacts.⁷

Under the Hazardous Waste Identification Regulations, a waste is identified as hazardous if it exhibits any of the four hazardous waste characteristics (ignitability, corrosivity, reactivity, or toxicity), or if it is a specifically defined listed waste. Wastes that contain mercury at levels that exceed the Toxicity Characteristic Leaching Procedure (TCLP) test level of 0.2 milligrams per liter (mg/L) are identified as hazardous wastes based on the toxicity characteristic. Waste mercury devices are usually hazardous wastes that need to be managed in compliance with the RCRA requirements.

3.4 THE BATTERY ACT

The Mercury-Containing and Rechargeable Battery Management Act (the Battery Act) was signed into law on May 13, 1996 to facilitate recycling of certain batteries that contain hazardous materials and to phase out the use of mercury in batteries. Title II of the Act prohibits the sale of any alkaline-manganese batteries (except for button cell batteries containing up to a maximum of 25 mg of mercury), most zinc-carbon batteries that contain mercury, and button cell mercuric-oxide batteries.⁸

3.5 PBT PRIORITY POLLUTANTS

Mercury has been targeted by the US EPA as a Persistent, Bioaccumulative, and Toxic (PBT) pollutant. The US EPA has developed a draft Mercury Action Plan that lays out actions the US EPA may take to reduce risks from and exposures to mercury.⁹ Among other provisions, the draft Mercury Action Plan has provisions to seek reductions in uses of mercury and to improve information and citizens' right to know about mercury. These use-reduction measures are intended to reduce the levels of mercury in waste streams as well as the danger of accidental releases.¹⁰

3.6 STATE REGULATIONS

Mercury-restrictive regulations have been introduced in legislation in Congress and in 19 states as of 2003. Mercury product regulations in Connecticut, Maine, New Hampshire, and Rhode

Island restrict mercury-added products and mercury-containing products. Several cities, including San Francisco, California; Ann Arbor, Michigan; Duluth, Minnesota; Boston, Massachusetts; Chicago, Illinois; and the states of New Hampshire, Maine, Maryland, and Minnesota have prohibited the sale, manufacture, and distribution of mercury thermometers within their jurisdictions.¹¹

3.7 NATIONAL INSTITUTES OF HEALTH

The National Institutes of Health (NIH) has an active mercury-free initiative. The Campaign for a Mercury Free NIH seeks to eliminate, as much as possible, the use of mercury in NIH facilities; encourage use of safer alternatives in biomedical research; increase general awareness of mercury hazards; and prevent mercury pollution.¹² The campaign is a voluntary pollution prevention initiative intended to improve awareness of mercury hazards and reduce the use of mercury at all NIH facilities. The program in place at the Warren G. Magnuson Clinical Center of NIH was held up by John E. Porter, Chairman of the House Subcommittee on Labor, Health and Human Services, and Education Appropriations, as an example of leadership in reducing the use of environmentally damaging chemicals in a research environment.

3.8 MEDICAL AND HEALTHCARE INITIATIVES

The Hospitals for a Healthy Environment partnership includes the American Hospital Association, the American Nurses Association, the US EPA, and Health Care without Harm in a national initiative to eliminate mercury in health care. The voluntary program set goals of a reduction in the total volume of hospital waste of 50% by 2010, and of eliminating nearly all hospital-generated mercury waste by 2005.

In 1999, the Assistant Secretary of Defense (Health Affairs) issued a memorandum supporting these goals, stating that the Military Healthcare System supports pollution prevention activities, material standardization, and other product acquisition initiatives to reduce costs while maintaining quality healthcare services¹³ (a copy of the memorandum is included in Appendix B). The memorandum states the Department of Defense preference for selection of environmentally preferable medical products. These initiatives are of interest to the Joint Group on Environmental Attributes because DLA's supply system manages a number of medical products containing mercury. The Department of Defense makes up 2% of the total market for medical/surgical products. In particular, the Defense Supply Center Philadelphia (DSCP) is responsible for purchasing a significant quantity of medical and surgical products. DSCP's total sales of medical/surgical products were over \$173 million in FY2000.

3.9 INTERNATIONAL INITIATIVES

The toxic effects of mercury extend beyond the U.S. borders. Mercury emitted to the atmosphere can travel thousands of miles before it is eventually deposited back to the earth in rainfall or in dry gaseous forms. Approximately two-thirds of the mercury emissions are caused by human activity (anthropogenic sources). As a result, global efforts are underway to reduce the discharge to the environment. Recent estimates, which are highly uncertain, of annual total global mercury emissions from all sources, natural and anthropogenic, are about 4,400 to 7,500 metric tons emitted per year. EPA has estimated that about one third of U.S. emissions are deposited within

the contiguous U.S. and the remainder enters the global cycle. Regulatory activities and government programs in Europe, Scandinavia, Asia, and Canada are all aimed at reducing the levels of mercury discharged into the environment, primarily by curtailing or reducing the use of mercury in commercial products, and by applying appropriate waste treatment practices in those processes where mercury can not be eliminated.

3.10 INDUSTRY GROUP INITIATIVES

Industry groups are pursuing voluntary programs to reduce mercury use and emissions. For example, the Chlor-alkali industry has pledged to voluntarily reduce its mercury emissions by 50%, and the auto industry is moving to replace mercury-switches in auto lamps with a safer substitute. GSA contracts for more than \$1 billion in non-tactical vehicles each year. Mercury-free vehicle components is one of several initiatives encouraged by EPA's green vehicle acquisition campaign developed in response to Executive Order 13149, Greening the Government through Federal Fleet and Transportation Efficiency, which was signed in April 2000¹⁴. State initiatives, such as the mercury-free specifications in Minnesota's 2002 vehicle bid documents, are also in-place and increasing. In response, automakers such as General Motors are beginning to reduce the use of mercury in new vehicles¹⁵.

4.0 PRODUCT CATEGORIES AND DEFINITIONS

4.1 EXISTING DEFINITIONS

To be useful in designating specific products as meeting an environmental attribute, the definition must be quantified and measurable. In other words, an item manager must be able to determine whether or not a specific product meets the definition of the attribute. Existing state regulations and Federal agency initiatives include definitions for mercury-added and mercury-containing products that are helpful in developing definitions for non-mercury alternatives as an environmental attribute.

Non-mercury alternative products are made without mercury and contain no added mercury. These products are replacements for products that traditionally contained mercury.

A ***mercury-added product*** is defined as any formulated or fabricated product that contains mercury, a mercury compound, or a component containing mercury, when the mercury is intentionally added to the product (or component) during manufacture. A ***fabricated mercury-added product*** is a combination of individual components, one or more of which has mercury added, that combine to make a single unit. A ***formulated mercury-added product*** is a chemical product, including but not limited to laboratory chemicals, cleaning products, cosmetics, pharmaceuticals, and coating materials that are sold as a consistent mixture of chemicals. The list of mercury-added products includes thermostats, thermometers, mercury switches, medical or scientific instruments, electric relay and other electrical devices, mercury lamps, and motor vehicle components.¹⁶

Concentration-specific definitions for ***mercury-containing*** products are included in mercury regulations developed by the states of Connecticut and Maine. The State of Connecticut's draft

regulations require a Certificate of Analysis for "mercury-containing formulated products" down to the 1 part per billion level.¹⁷ Maine requires a Certificate of Analysis for a mercury-containing product used in hospitals unless the concentration is less than 200 parts per trillion.

Table 4-1 lists the mercury-added product phase-out requirements in Connecticut, Rhode Island, and Maine. These states restrict the sale or distribution of any mercury-added product that contains mercury in excess of the established limits unless an exemption is granted by the state.

TABLE 4-1: LIMITS ON PRODUCTS BASED ON MERCURY CONTENT AND COMPLIANCE DATES¹⁸

State	Effective Date	Regulated Products	Established Limit on Mercury Content
Connecticut	July 1, 2004	Formulated mercury-added products	250 ppm
	July 1, 2004	Fabricated mercury-added products	1,000 mg
	July 1, 2006	Fabricated mercury-added products	100 mg
	July 1, 2006	Formulated mercury-added products	50 ppm
Rhode Island	July 1, 2005	Formulated mercury-added products	250 ppm
	July 1, 2005	Fabricated mercury-added products	1,000 mg
	July 1, 2007	Fabricated mercury-added products	100 mg
	July 1, 2007	Formulated mercury-added products	50 ppm
	July 1, 2009	Fabricated mercury-added products	10 mg
	July 1, 2009	Formulated mercury-added products	10 ppm
Maine	January 1, 2006	Mercury-added thermostats (non-manufacturing)	Not applicable; state law targets certain types of products
	July 1, 2006	Specified mercury-added instruments and measuring devices; and switches and relays	Not applicable; state law targets certain types of products

For purposes of implementing the environmental attribute, non-mercury alternative products are those that can be used instead of mercury-added or mercury-containing products. Non-mercury products are made without mercury and do not contain added mercury. (However, because these products may contain trace levels of mercury that are unintentionally present in the product, they may not be entirely "mercury-free".)

4.2 PRODUCT CATEGORIES

Mercury is contained in many products in a wide variety of industries, both as an added ingredient and as a consequence of a manufacturing method. Many of these products are available through the federal supply system. For purposes of developing the Environmental Attribute for non-mercury alternative products managed by DLA, products can be grouped into several categories, as shown in Table 4-2.

**TABLE 4-2: PRODUCT CATEGORIES INCLUDED IN THE
ENVIRONMENTAL ATTRIBUTE NON-MERCURY ALTERNATIVES**

Category	Product Type	Federal Stock Class (FSC) Number¹⁹	Inventory Control Point
Medical Products	Thermometers	6515 -- Medical, Surgical Instruments, Equipment and supplies	S9M/KX -- Defense Supply Center, Philadelphia (Medical)
	Sphygmomanometers (blood pressure monitors)	6545 -- Replenishable Field Med Sets, Kits and Outfits	
	Esophageal dilators (also called bougie tubes)	6550 -- In-vitro diagnostic substances, reagents, test kits and sets	
	Cantor tubes and Miller Abbott tubes (used to clear intestinal obstructions)		
	Feeding tubes		
Laboratory Chemicals	Fixatives, stains, reagents, preservatives	6505 -- Drugs, Biologicals, and Official Reagents 6550 -- In-vitro diagnostic substances, reagents, test kits and sets	S9M/KX -- Defense Supply Center, Philadelphia (Medical)
Dental Products	Dental Amalgams	6520 -- Dental Instruments, Equipment, and Supplies	S9M/KX -- Defense Supply Center, Philadelphia (Medical)
Consumer Products	Float Switches	5930 -- Switches	S9E/TX -- Defense Supply Center, Columbus (Electronics)
	Electrical Switches		
	Thermostats	5935 -- Electrical Connectors 6110 -- Electrical Control Equipment	S9E/TX -- Defense Supply Center, Columbus (Electronics) S9G/CX -- Defense Supply Center, Richmond
	Thermometers	6685 -- Pressure, Temperature, and Humidity Measurement and Control Instruments	S9G/CX -- Defense Supply Center, Richmond
	Pressure gauges	6685 -- Pressure, Temperature, and Humidity Measurement and Control Instruments	S9G/CX -- Defense Supply Center, Richmond
	Barometers	6660 -- Meteorological Instruments and Apparatus	S9G/CX -- Defense Supply Center, Richmond
	Flow meters	6680 -- Liquid, Gas Flow, Liquid Level and Mechanisms Motion Measuring Instruments	S9G/CX -- Defense Supply Center, Richmond
Vehicles	Vehicles with non-mercury components	2310 -- Passenger Motor Vehicles	FAA/75 -- General Services Administration,

Category	Product Type	Federal Stock Class (FSC) Number ¹⁹	Inventory Control Point
		2920 -- Engine Electrical System Components, Nonaircraft	Vehicle Acquisition and Leasing Service S9C/AX -- Defense Supply Center, Columbus (Construction)

4.3 NON-MERCURY ALTERNATIVES

Non-mercury alternatives are available for many medical products²⁰ and other product categories. Table 4-3 provides a brief summary of the alternatives for each product category, including a comparison of purchase and use costs and technical information for each substitute^{21, 22}. The technical requirements for retrofitting existing equipment with non-mercury alternatives need to be determined on a case-by-case basis. Non-mercury alternatives should be selected wherever possible in new applications.

TABLE 4-3: SUMMARY OF MERCURY ALTERNATIVES

Product Category and Type	Alternatives Available	Cost and Technical Comparison
MEDICAL PRODUCTS		
Thermometers ²³ (for measuring patient temperature)	Electronic (digital) and tympanic (infrared) thermometers: oral/rectal	Cost of electronic and tympanic thermometers approximately \$300 plus pennies each for disposable probe covers, versus approximately \$0.40 for standard mercury thermometer. Accuracy comparable to mercury. Time for reading: seconds versus 5 to 7 minutes for mercury thermometer. Requires batteries.
	Chemical strip, single-use disposable (plastic or paper strips with dots filled with different chemical mixtures, each formulated to melt and change color at a given temperature)	Cost: pennies apiece. Accuracy comparable to mercury thermometers. Time for reading: 1 minute (oral) to 3 minutes (axilla). Limited temperature range: 35°C (95°F) and above.
	Glass filled with alloy of gallium, indium, and tin (liquid at room temperature)	Cost: approximately \$3.00. Accuracy comparable to mercury thermometers. Time for reading: 3 minutes. Disadvantage: breakable, but no more so than standard mercury thermometers which have a life expectancy of 80 days in a hospital setting if reused.
Sphygmomanometers (blood pressure monitors)	Aneroid (mechanical dial) sphygmomanometer	Cost: \$50-\$80 for wall model (adult) and \$30-\$35 for portable model (adult), compared with \$60-\$70 for standard mercury sphygmomanometer. Accuracy comparable to mercury. Requires

Product Category and Type	Alternatives Available	Cost and Technical Comparison
		calibration annually, same as for mercury devices.
	Electronic sphygmomanometer	Cost: approximately \$2,000. Accuracy comparable to mercury. Commonly used where long-term continuous monitoring is needed, such as intensive care.
Esophageal dilators (also called bougie tubes)	Bougie tubes weighted with tungsten gel	Considered to be as effective as mercury. Eliminates concern for "spill" of mercury inside the patient's body. Costs are comparable. Tungsten gel bougies range from \$3,000 to \$4,400 versus mercury bougies at \$3,395. As a hazardous material, disposal costs for mercury bougies are higher, compared with the cost for disposal of tungsten bougies in the general trash. Tungsten is a safer, more environmentally benign alternative compared to mercury ²⁴ , with no known chronic health effects. ²⁵
Cantor tubes (used to trace the gastrointestinal (GI) tract)	Cantor tubes weighted with tungsten	Tubes can be purchased empty and hospital adds the weighting material, either mercury or tungsten. Costs are comparable. Some feel tungsten weighting is not as effective as mercury because it is not as heavy. Eliminates concern for "spill" of mercury inside patient's body. Tungsten is a safer, more environmentally benign alternative compared to mercury, with no known chronic health effects.
Miller Abbott tubes (used to clear intestinal obstructions)	Tubes weighted with tungsten	Tubes can be purchased empty and hospital adds the weighting material, either mercury or tungsten. Tungsten replacement is considered as effective as mercury. Eliminates concern for internal release of mercury. Tungsten is a safer, more environmentally benign alternative compared to mercury, with no known chronic health effects.
	Tubes weighted with air or saline	Air-weighted tubes have the disadvantage that they take longer to go through the system compared with mercury-weighted tubes; these alternatives require an additive to the saline to be viewed on X-ray. Eliminates concern for internal release of mercury.
Feeding tubes	Tungsten	Considered to be as effective as mercury, without concern for release of mercury inside patient. Costs are comparable.
LABORATORY CHEMICALS		
Histological fixatives (such as B5 and Zenker's Solution) with mercury (II) chloride as a tissue	Zinc formalin and other products are alternative fixatives and preservatives	The appropriate alternative for mercury in laboratory chemicals depends on the reason that mercury is present. Mercury-containing laboratory chemicals can often be replaced by compounds

Product Category and Type	Alternatives Available	Cost and Technical Comparison
preservative		containing less hazardous metals (e.g., zinc formalin to replace mercury (II) chloride as a histological fixative or preservative), or non-mercury formulations. Examples are listed at left. Mercury concentrations of laboratory chemicals currently in use are typically listed on a Certificate of Analysis.
Mercury (II) chloride as an oxidizer in hematoxylin	Sodium iodate is an alternative oxidizer	
Use of mercury-containing chemicals for acidic drug analysis of barbiturates and benzodiazepines by thin layer chromatography (such as Toxi-Dip B3)	Gas chromatography and mass spectrometry are alternative methods	
Thimerosal (Trademark Merthiolate) as a preservative in stains and other products in the pH neutral range	Methyl paraben and propyl paraben are alternative preservatives	
DENTAL PRODUCTS		
Dental Amalgams	Gold, ceramics, porcelain, and polymeric alternatives are available	Mercury-containing dental amalgams do not pose a health risk, but disposal of waste amalgam can be a source of mercury release to the environment.
CONSUMER PRODUCTS		
Fluorescent lights and mercury-containing lamps	Reduced-mercury lighting alternatives are available for many applications	Light-emitting diode (LED) lighting made without added mercury is available for use in applications where low level lighting is adequate, such as exit signs and markers. ²⁶ The purchase cost of lower mercury content lamps is generally comparable to the cost of lamps with higher mercury content.
Float Switches (used for liquid monitoring and control in septic tanks, sump pumps, industrial liquid tanks, sewage plant systems, and other applications)	Mechanical float switches, magnetic dry reed switches, optical float switches, conductivity float switches, metallic ball float switches, sonic/ultrasonic, pressure transmitter, gallium indium alloy, thermal float switches, and capacitance level float switches are alternatives for mercury float switches	Numerous non-mercury alternative technologies exist that are cost competitive and technically acceptable compared to mercury float switches. The appropriate alternative is application-dependent.
Electrical Switches (switches in electrical equipment, relays, boilers, cooling and	Switches and electronic ignition devices made without added mercury are available. Alternatives to mercury tilt	Pressure switches, temperature switches, and relays made without added mercury generally are comparably priced to mercury switches and can

Product Category and Type	Alternatives Available	Cost and Technical Comparison
heating equipment, mercury-containing wall-mounted light switches manufactured before 1991)	switches include metallic ball, electrolytic, potentiometers, mechanical, solid-state, and capacitive tilt switches. Alternatives to mercury pressure switches include mechanical pressure switches and solid-state pressure switches. Alternatives to mercury temperature switches include mechanical temperature switches and solid-state temperature switches. Alternatives to mercury relays include dry magnetic reed relays, other electro-mechanical relays, solid-state relays, silicon controlled rectifiers, and hybrid electromechanical /solid-state relays.	meet the functional requirements.
Thermostats (for temperature control in buildings, equipment, cold rooms, water treatment facilities, and other locations)	Electronic thermostats, digital, electromechanical, and programmable alternatives made without added mercury are available	Alternatives made without added mercury are available at comparable prices. Depending on the application, thermostats without mercury may be cheaper. Alternatives have comparable or better accuracy than mercury devices. The cost for programmable thermostats may be higher, but savings can be achieved in cooling and heating bills through greater control of temperatures.
Thermometers	Electronic thermometers, digital, and alcohol and other non-mercury liquid thermometers	Non-mercury thermometers are available at comparable prices to the mercury devices for most applications. Use of non-mercury thermometers reduces the risk of mercury spills and mercury discharge down the drain.
Ovens, refrigerators, stoves, and freezers (mercury flame sensors)	Gas appliances with electronic ignitions are available in place of mercury flame sensors. Appliances are also available with hard-contact switches, solid-state switches, electro-optical switches, inductive sensors, capacitive sensors, photoelectric sensors, and ultrasonic sensors instead of mercury in these applications.	Electronic ignition systems are cost effect and functional replacements for mercury flame sensors and are currently in use in many applications. The electronic ignition system may not be a safe alternative to the mercury flame sensor in remote areas or where electricity is intermittent.
Pressure gauges (manometers, carburetor synchronizers, etc.)	Aneroid, digital, and electronic manometers and analog gauges (vacuum gauges) made without	Alternatives without mercury are available at comparable prices for most uses. Mercury-filled manometers are generally more expensive than water- or mineral spirit-filled models. Digital

Product Category and Type	Alternatives Available	Cost and Technical Comparison
	added mercury	manometers are more expensive, running to ten times the price of a mercury-filled manometer. Digital manometers are recognized as highly accurate and are already the preferred instrument in some applications.
Barometers	Aneroid, digital, and water barometers are available.	Digital barometers typically cost \$50-\$300. Mercury and aneroid barometers range from \$100 to over \$1,000; as common collector's items, their prices are inflated. Aneroid and digital barometers are considered to be as accurate as mercury barometers.
Flow meters (e.g., flow meters used in water and sewer plants, power stations, and heating plants; household gas meters made before 1961)	Digital and ball actuated flow meters are available for most applications.	Mercury flow meters are no longer manufactured. Alternatives without added mercury available to replace older mercury flow meters and for new applications are cost effective and technically acceptable.
VEHICLES		
Vehicles (mercury can be present in antilock braking systems, light switches for the hood and trunk, headlights, and other components)	Alternative components without added mercury are available	Alternative components without mercury are comparable in terms of cost and performance. Vehicles that are free of some or all mercury-added components are available through various manufacturers.

5.0 LIFE-CYCLE COST/BENEFIT ANALYSIS

Use of non-mercury alternatives provides benefits to the environment and personal health, and provides cost benefits through comparable costs for purchase and use of alternatives, coupled with lower handling and disposal cost.

The environmental benefit of using non-mercury products is a reduction in the quantity of mercury released to the environment. Mercury can be released during the entire product life-cycle, including production, transportation, manufacturing, use, and disposal. In many mercury-containing devices, such as thermometers and manometers, the mercury is contained within glass, which can easily break and spill mercury to the environment. And, mercury-containing devices are often disposed improperly, resulting in mercury emissions from trash incinerators and landfills²⁷. One research group found that, "although no one knows the true price or degree of mercury pollution, the rate of a gram of atmospheric mercury currently deposited annually per 20 acre surface area lake in the U.S. has resulted in fish consumption advisories for mercury in 40 states²⁸."

Once released, the mercury can readily disperse in the environment through the air, soil, and water. It can also be transformed to organic forms, such as methylmercury, the most toxic form of mercury. Mercury is persistent in the environment, and bioaccumulates within the food chain. The U.S. EPA includes mercury as one of the priority pollutants in its persistent bioaccumulative and toxic (PBT) chemical program. Mercury is highly toxic to humans, posing greatest risk to pregnant women, women of child-bearing age, small children, and the fetus. Mercury is a reproductive toxin and potent neurotoxin. Exposure to mercury can damage kidneys, the brain, and the central nervous system. The Centers for Disease Control and Prevention found that one in ten women have mercury levels high enough to cause neurological damage in their children, affecting nearly 400,000 babies each year.²⁹ The environmental presence of mercury also results in severe impacts to wildlife, including early death, weight loss, and reproductive issues.³⁰

In addition to the environmental benefits of reduced mercury releases, use of non-mercury products include cost benefits of reduced compliance, disposal, and clean-up costs. Health benefits include reduced risk of personnel exposure to mercury liquid and vapor during use of equipment, and reduced risk of patient exposure to mercury through spills and releases (both to the environment and within the patient's body).

Life-cycle costs associated with use of mercury products include compliance costs, training, monitoring, recordkeeping, employee safety and health compensation, costs associated with collection and storage prior to disposal, and waste disposal costs. Kaiser Permanente found that for every \$1 spent in spill response for mercury from medical devices, another \$1.75 is spent on training, fines, and treatment of exposures.³¹

Documented costs for clean-up of mercury spills from medical devices range from \$1,000 for a small spill (e.g., a spill from a typical mercury thermometer) to \$570,000 (e.g., to clean up a widespread spill of mercury resulting from sink traps that were piled up and carried across campus).³²

Many non-mercury alternatives are comparably priced to the mercury products. Price comparison information is provided in Table 4-2 for many of the alternative products. Even where non-mercury products are more expensive initial purchases, significant savings are associated with avoided waste disposal and handling costs.

6.0 IMPLEMENTATION

Implementing the non-mercury alternatives environmental attribute involves identifying products that are eligible for the ENAC. Specifically, these are products for which a market still exists for the mercury-containing product and for which a suitable non-mercury alternative has been identified. Implementing the environmental attribute for these products may encourage buyers to choose the suitable non-mercury alternative in place of the mercury-containing product, an environmentally-preferable choice.

DLA has identified several mercury-containing products in the supply catalog. As shown in Table 6-1, non-mercury alternatives are available for some of these products; for others, no non-

mercury alternatives have been found suitable to meet the technical requirements of the intended application. The non-mercury alternatives are eligible for an environmental attribute.

TABLE 6-1: MERCURY-CONTAINING PRODUCTS IDENTIFIED IN THE SUPPLY SYSTEM

Product	Inventory Control Point	Suitable Non-Mercury Alternative?
Shipboard alarm system detectors and switches (MIL-S-16302(SH))	DSC-Columbus	Manufacturer states no non-mercury alternative is available for the intended application
Mercury Wetted Reed Relay (MIL-R-83407/3C)	DSC-Columbus	Manufacturer states no non-mercury alternative is available for the intended application
Mercury thermostats	DSC-Columbus	Digital thermostats
Amalgam filling kits	DSC-Philadelphia	Non-mercury amalgam filling kits
Lighting	DSC-Philadelphia	Non-mercury LED lights are available, but do not meet the lumen capacity for direct replacement of fluorescent lamps
Temperature and Pressure indicators	DSC-Richmond	Digital and other non-mercury alternatives are available.

For some product categories this may require developing contract language to require manufacturers to disclose mercury content. For alternatives made without mercury, such as electronic or digital thermometers and tungsten feeding tubes, the materials of construction may provide sufficient evidence that the products are eligible for the ENAC. A manufacturer's certification can also be obtained to provide assurance the product does not contain mercury.

7.0 RECOMMENDATIONS

Policy priorities exist and cost benefits are evident for use of non-mercury products. Because of the numerous policy priorities and initiatives and the large potential impact on reduced toxicity and health benefits, DLA should establish **non-mercury alternatives** as an environmental attribute. The recommended definition of a **non-mercury alternative** is a product that is a replacement for a product that traditionally contained mercury that has no mercury added during manufacturing.

A proposed list of product categories for the non-mercury alternatives environmental attribute is provided in Table 7-1 below. The proposed categories are only those for which mercury products and suitable alternatives have been identified in the supply catalog. **As a priority recommendation, DLA should establish the non-mercury environmental attribute for the categories listed in the EO 13148, Section 503 Target Chemical List, which are temperature**

and pressure measuring devices (medical and industrial) and mercury switches. DLIS will assign the ENAC codes upon adoption of non-mercury alternatives as an environmental attribute.

To implement the non-mercury alternatives environmental attribute, DLA will need to communicate information on the new attribute to the product centers, procurement, cataloging, and other activities so that action can be taken to identify new and existing products that meet the criteria. Internal DLA protocols are being established to standardize the approach and steps to implement the attributes.

TABLE 7-1: PROPOSED PRODUCT CATEGORIES FOR THE NON-MERCURY ALTERNATIVES ENVIRONMENTAL ATTRIBUTE

Proposed Category	Applicable Products	Product Manager
Dental Products	Non- mercury dental amalgams	Defense Supply Center, Philadelphia
Consumer Products	Non-mercury thermostats	Defense Supply Center, Columbus
	Non-mercury thermometers	Defense Supply Center, Richmond
	Non-mercury pressure gauges	Defense Supply Center, Richmond
	Non-mercury barometers	Defense Supply Center, Richmond

APPENDIX A

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

DLA	Defense Logistics Agency
DSCP	Defense Supply Center Philadelphia
ENAC	Environmental Attribute or Characteristic Code
EPPs	Environmentally Preferable Products
FLIS	Federal Logistics Information System
GSA	General Services Administration
JGEnvAtt	Joint Group on Environmental Attributes
LDR	Land Disposal Restrictions
NIH	National Institutes of Health
PBT	Persistent, Bioaccumulative, and Toxic
RCRA	Resource Conservation and Recovery Act
ROHS	Reduction of Hazardous Substances
TCLP	Toxicity Characteristic Leaching Procedure
USDA	U.S. Department of Agriculture

APPENDIX B
MEMORANDUM: PREFERENCE FOR SELECTION
OF ENVIRONMENTALLY PREFERABLE
MEDICAL PRODUCTS

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
UNDER SECRETARY OF DEFENSE (ACQUISITION &
TECHNOLOGY)
DEPUTY UNDER SECRETARY OF DEFENSE
(ENVIRONMENTAL SECURITY)
DIRECTOR, DEFENSE LOGISTICS AGENCY
THE SURGEON GENERAL, ARMY
THE SURGEON GENERAL, NAVY
THE SURGEON GENERAL, AIR FORCE

SUBJECT: Preference for Selection of Environmentally Preferable Medical Products

On September 14, 1998, the President signed Executive Order (EO) 13101, Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition. The new EO is designed to further expand and strengthen the Federal government's commitment to recycling and buying recycled content and environmentally preferable products. "Environmentally preferable" means products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. DoD and other Federal agencies are required to implement the requirements of a Strategic Plan released on March 12, 1999, by the White House Task Force on Greening the Government Through Waste Prevention and Recycling.

The Department of Defense encourages the use of recycled products at all DoD installations and supports the use of environmentally preferable products to achieve DoD's environmental security goals. On March 19, 1999, the Office of the Under Secretary of Defense (Acquisition and Technology) issued a memorandum on DoD's Affirmative Procurement Program (APP) revised to include the 12 new guideline items that the U.S. Environmental Protection Agency designated. The Environmental Protection Agency in June 1998 had previously announced a voluntary partnership with the American Hospital Association to work together to reduce hospital waste generation consistent with their responsibilities to safeguard human health and the environment. Specifically, their goals include virtual elimination of hospital-generated mercury waste by 2005, and reduction of total hospital waste volume by 33% by 2005 and 50% by 2010. An environmentally preferable purchasing effort will investigate hospital products and services that are less harmful to the environment and minimize waste management costs.

The Military Healthcare System is committed to responding to the challenges inherent in our changing roles and missions and supports pollution prevention activities, material standardization and other product acquisition initiatives to reduce costs while maintaining quality healthcare services. It is the policy of the Department of Defense to support environmental preferable purchasing. Medical treatment facilities and direct users and buyers of medical products should consider the environmental and life cycle costs of the manufacturing, packaging, use and disposal of products and environmentally preferable alternatives in their purchasing decisions.

Dr. Bailey

APPENDIX C

ENDNOTES AND REFERENCES

ENDNOTES AND REFERENCES

- ¹ U.S. Office of the Federal Environmental Executive, "Executive Order 13101," Part 4, Section 401, www.ofee.gov/eo/13101.htm.
- ² EO 13148, Section 503 - 15 Target Chemicals, NAVAIR 8.7, LMTCE, and NFESC Federal Register Summary, Updated to August 15, 2001, <http://www.enviro-navair.navy.mil>.
- ³ Appendix 8. Priority Chemical List (EO 13148 Section 503 Chemical List), USDA, July 2003, <http://www.aphis.usda.gov/mrpbs.pdf>.
- ⁴ Mercury Regulations and Standards, US EPA web site, http://www.epa.gov/epaoswer/hazwaste/mercury/reg_stand.htm.
- ⁵ Streamlined Regulations for Universal Waste, Waste-Specific Technical Requirements, U.S. Environmental Protection Agency, <http://www.epa.gov/epaoswer/hazwaste/id/univwast/wasts.htm>, September 27, 2004.
- ⁶ Environmental Fact Sheet: Some Used Lamps are Universal Wastes, U.S. Environmental Protection Agency, EPA530-F-99-024, July 1999.
- ⁷ More Recycling and Reuse Proposed for Electronic Wastes and Mercury-Containing Equipment, U.S. Environmental Protection Agency Fact Sheet, EPA530-F-02-018, April 2002.
- ⁸ Implementation of the Mercury-Containing and Rechargeable Battery Management Act, U.S. Environmental Protection Agency, EPA530-K-97-009, November 1997.
- ⁹ Persistent Bioaccumulative and Toxic (PBT) Chemical Program, US EPA web site, <http://www.epa.gov/pbt/execsumm.htm>.
- ¹⁰ Draft PBT National Action Plan for Mercury, prepared by the US EPA Persistent, Bioaccumulative and Toxic Pollutants (PBT) Program, 1998, <http://www.epa.gov/pbt/hgaction.htm#A>. (Note that the Mercury Action Plan is under development and was not available for review for this analysis.)
- ¹¹ Making Medicine Mercury-Free, A Resource Guide for Mercury-Free Medicine, Health Care without Harm, <http://www.noharm.org>.
- ¹² Mad as a Hatter? Join our Campaign for a Mercury Free NIH, <http://www.nih.gov/od/ors/ds/nomercury>.
- ¹³ Memorandum for Secretaries of the Military Departments: Under Secretary of Defense (Acquisition & Technology); Deputy Under Secretary of Defense (Environmental Security); Director, Defense Logistics Agency; The Surgeon General, Army; The Surgeon General, Navy; The Surgeon General, Air Force. Subject: Preference for Selection of Environmentally Preferable Medical Products. Written by: Dr. Bailey, Assistant Secretary of Defense (Health Affairs). 1999.
- ¹⁴ Drawing a Road Map for Green Vehicle Acquisitions, EPP Update Newsletter, U.S. Environmental Protection Agency, January 2003.
- ¹⁵ Mercury-free and More: INFORM's Purchasing Initiative Gets Results, INFORM Reports, Spring 2002.
- ¹⁶ State of Maine regulations, Title 38: Waters and Navigation, Chapter 16-B: Mercury-Added Products and Services, <http://janus.state.me.us/legis/statutes/38/title38sec1661.html>.
- ¹⁷ Toward the Virtual Elimination of Mercury from the Solid Waste Stream, Connecticut Department of Environmental Protection, Appendix C, Sample draft legislation, March 2000, <http://www.dep.state.ct.us/wst>.
- ¹⁸ State Mercury-Added Product Phase-out Information, Northeast Waste Management Officials' Association (NEWMOA), Interstate Mercury Education & Reduction Clearinghouse (IMERC), <http://www.newmoa.org/prevention/mercury/imerc.cfm>, December 10, 2003.
- ¹⁹ Federal Supply Class Assignments and Inventory Control Points were taken from the Customer Assistance Handbook, Fourteenth Edition, Logistics Operations, Defense Logistics Agency, 2002.
- ²⁰ The Sustainable Hospital Project, sponsored by the Lowell Center for Sustainable Production and the University of Massachusetts Lowell, provides information and technical support on available alternatives.
- ²¹ Information on mercury alternatives is available in mercury-Containing Products and Alternatives, Purchasing for Pollution Prevention Project, INFORM, Inc., May 2003.
- ²² Detailed discussion of alternatives for many of the product categories, including vendors, points of contact, price comparison, and technical evaluation, is provided in "An Investigation of Alternatives to Mercury Containing Products, Lowell Center for Sustainable Production, prepared for The Maine Department of Environmental Protection, January 22, 2003.
- ²³ Promoting a Healthier Environment, <http://www.epa.gov/grtlakes/bns.PDF>.
- ²⁴ An Investigation of Alternatives to Mercury Containing Products, Lowell Center for Sustainable Production, prepared for the Maine Department of Environmental Protection, January 22, 2003.

²⁵ The known health effects of tungsten include irritation to the skin and eyes from exposure to tungsten dust, but no known chronic effects have been identified. Most tungsten that enters the body is rapidly released from the body in the urine and feces. Reference: Agency for Toxic Substances and Disease Registry, Public Health Statement, Tungsten, 2004.

²⁶ E-mail communication from Anthony Armentani, DSCP, to Lori Stoll, The Louis Berger Group, Inc., dated December 15, 2003, regarding the availability of mercury-free lighting.

²⁷ Purchasing for Pollution Prevention: Mercury-Free Industrial Thermometers, Manometers, Thermostats, and Switches Fact Sheet, INFORM, Inc., http://www.informinc.org/fact_P3industrialmeters.php.

²⁸ Quote is from "Mercury Millennium Product Phase Out", Mercury Policy Project, Montpelier, VT. The original reference cited is Assessment of Mercury Contamination in Selected Minnesota Lakes and Streams, Report to the Legislative Commission on Minnesota Resources, Executive Summary, MPCA, 1989.

²⁹ Toxicological Effects of Methylmercury, National Academies of Science, National Research Council, July 2000.

³⁰ An Investigation of Alternatives to Mercury Containing Products, Lowell Center for Sustainable Production, prepared for The Maine Department of Environmental Protection, January 22, 2003.

³¹ Tellus Institute, 2000.

³² An Investigation of Alternatives to Mercury Containing Products, Lowell Center for Sustainable Production, prepared for the Maine Department of Environmental Protection, January 22, 2003, <http://www.maine.gov/dep/mercury/lcpsfinal.pdf>.